Dielectric Relaxation Studies of Agricultural Products

Synopsis

Submitted to

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

For the registration of the topic for

Doctor of Philosophy

in the subject of **PHYSICS**

(Faculty of Science)

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Abstract of proposed work plan/problem:

“Dielectric Relaxation Studies of Agricultural Products”

1. Introduction :

The dielectric permittivity of a material determines the interaction of that material with electric fields. The frequency dependant complex permittivity relative to free space $\varepsilon^*(\omega) = \varepsilon'(\omega) - j\varepsilon''(\omega)$, is a complex term in which ε' (the real part) is known as dielectric permittivity, it is associated with the capability of energy storage in the material and ε'' (the imaginary part) is the dielectric loss factor and includes all losses, mainly those due to dipolar relaxation and ionic conduction. In recent years, dielectric measurements have become an effective tool for extracting significant information related to the structure and to the quality-status of various materials. In this field, many scientific efforts have been done to the dielectric spectroscopy of liquids [1–5], since several industrial applications require an on-line continuous monitoring of the processing quality status. In fact, different techniques allowing the measurement of the permittivity spectrum can be successfully implemented for characterizing various liquid products from a qualitative point of view [6]. Dielectric properties or permittivity of agricultural products are of interest due to many reasons [7]. Dielectric spectroscopy has major applications for sensing of moisture content in these products through its correlation with the dielectric properties. Other application, of dielectric properties of agricultural materials is use in research on potential dielectric heating applications [8-10].

2. Review of Literature and Development in the subject (Previous work done in the relevant area)

In literature, it is found that Nelson et.al. extensively carried out the measurement of dielectric properties in different frequency ranges from RF to microwave. These dielectric properties of agricultural products are used for sensing moisture in grain and seed and their application. The values for the dielectric properties of a number of products (grain and seed, fruits and vegetables, and poultry products) are studied [11-12]. Recently, the frequency and temperature dependence of the permittivities of a few agricultural materials have been investigated [13-20].

3. Objectives of Research/Proposed hypothesis:

- The dielectric measurement of some agricultural products (vegetables, fruits, plant leaves extract) and food materials in liquid form in different frequency ranges.
- Evaluate the dielectric parameters such as static dielectric constant, relaxation time, high frequency dielectric permittivity using the experimental data.
- To study the effect of temperature and aging on the dielectric properties of these materials

4. Methodology

Time Domain Reflectometry (TDR) technique is very much useful for measurement of complex permittivity spectra in broad range of frequencies in single measurement. A fast rising voltage pulse with repetition frequency of few KHz with rise time of picosecond is allowed to transmit through a coaxial line with characteristic impedance 50 ohm. The co-axial cable semirigid, copper, with flat end can be used. Sampling oscilloscope monitors changes in the pulse after reflection from the end of line. Reflected pulse without sample $R_1(t)$ and with sample

$R_x(t)$ were digitized with suitable sampling points in the window. Mismatch in the impedance of these reflected pulses will be used to extract the complex permittivity spectra of liquid under test through data analysis [21].

The low frequency dielectric measurement can be done using Precision LCR meter (Frequency Domain) technique. The complex relative dielectric function $\varepsilon^*(\omega)$ of liquid samples can be measured in the frequency range few Hz to some MHz. In this technique, the capacitance and parallel resistance of the liquid dielectric test fixture without and with samples were measured to compensate for a short [22-23].

5. Importance of study/society application:

The following scientists are doing research in this field at national/international level

- **International status:**
  1. S O Nelson, US Department of Agriculture, Agricultural Research Service, Athens, GA 30604-5677, United States
  2. Andrea Cataldo, Department of Engineering for Innovation - University of Salento, via Monteroni, 73100 Lecce, Italy
  3. Emanuele Piuzzi, Department of Information Engineering, Elect. & Tele.- Sapienza University of Rome, via Eudossiana 18,00184 Rome, Italy
  4. U Kaatze, Drittes Physikalisches Institut Georg-August-Universität Göttingen, Germany.
- **National Status:**
  1. S C Mehrotra, Dr. BAMU, Aurangabad (MS).
  2. R J Sengwa, JNV University, Jodhpur, Rajhsthan.
  3. A C Kumbharkhane, SRTM University, Nanded (MS).

4. V A Rana, Gujrat University, Ahmedabad (Gujrat).

❖ **Significance of the study**

Dielectric spectroscopy has been provided its usefulness in agricultural research. Developments in instrumentation and techniques in either frequency domain or time-domain systems make the assembly of dielectric properties information much more efficient. Assessment of the potential for selective dielectric heating for control of insects or other organisms in agricultural products can be aided materially by the application of dielectric spectroscopy to permit an intelligent selection of frequency ranges to explore. The sensing of maturity or other quality factors in fruits and vegetables can be explored. Studies of the correlation of dielectric spectrographic information with quality factors of agricultural products may well lead to useful techniques for the rapid characterization of agricultural materials. Dielectric spectroscopy over broad ranges of frequency may also reveal information on the binding of water in food and other agricultural materials.

6. Proposed work plan/Formulation and structure of study:

- **First Year:** To study theoretical background of research problem and detail literature survey. The dielectric measurement of some agricultural products (vegetables, fruits, plant leaves extract) and food materials in liquid form in different frequency ranges.
- **Second Year:** Evaluate the dielectric parameters such as static dielectric constant, relaxation time, high frequency dielectric permittivity using the experimental data. To study the effect of temperature and aging on the dielectric properties of these materials
- **Third Year:** To discuss the results obtained from the dielectric data. To publish the work in research journals of repute and presenting the work in conference/seminars. Finally, write up the research work for doctoral thesis.

7. References:

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